REDEFINITION OF THE UNIFICATION PROBLEM

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Abstract. Unification of the forces of nature has been achieved by redefinition of the unification problem. The concept of force was mathematically defined using a generic field theory to yield four force laws that converge on a specific superforce at the Planck scale of the big bang. Gravity is included. Other results using just the four redefined force laws are: solution of Einstein's unified field theory; derivation of a force law for the strong force; discovery of a theoretical structure for the overall electromagnetic spectrum; explanation of the Casimir effect; resolution of the Dirac large number hypothesis and the Eddington number; prediction of a maximum atomic orbit; and, integration of all of the above into a coherent design of the universe from gravitational collapse to the edge of space.

Introduction and Need for Redefinition

The fondest wish of scientists since about 1850 has been to unify two or more of the forces of nature. Since about 1950 the goal of the unification problem has been to unify the four fundamental forces. These are the gravitational, electromagnetic, strong and weak forces. The so-called standard model has unified all but gravity. Unification of all four forces is still a goal of string theory. In other words, unification is still an open problem. In my opinion, any problem that remains unsolved for an extended period, in spite of the best efforts of the most competent practitioners in the field, is a problem that needs to be redefined. The purpose of this paper is to show that progress in unification may be possible using a comprehensive redefinition of the unification problem.

Mathematical Definition of Force

The standard model approach to unification of the forces of nature is based upon quantum field theory. The objective of quantum field theory is to show that the particles that mediate different forces are members of the same family. As an engineer, rather than a physicist, I decided to use an approach to unification that was based upon the forces themselves. My intent was to find a way to derive force laws to describe phenomena and then identify the interactions, and possible unification, of these force laws. A force law is an equation where the magnitude of a force is a function of some quantity, in this case, distance. In 1980, I developed a model, which is called the *generic field theory*, to derive several force laws [1].

The objective of the generic field theory was to derive a mathematical definition of force that was independent of any phenomena and then couple this definition to nature with some general hypothesis. Starting with a field of space, $f(\mathbf{r})$, define a scalar potential, $\phi(\mathbf{r})$, at every point in the field. This is a known practice. Then, define a field constant, ρ, that is constant over the entire field and does not vary with position in the field. This step, I think, is new. Next, arbitrarily define the potential energy, $U = \rho\phi(r)$. As is usual, define the force, $\mathbf{F}$, as the negative gradient of the potential energy, $\mathbf{F} = -\rho\nabla\phi(\mathbf{r})$. The force per unit field constant is defined as the field strength, $\mathbf{V} = -\nabla\phi(\mathbf{r})$, which is also called the gradient vector. These definitions can be related to other mathematical definitions, such as: kinetic energy, work, Lagrangian, Laplacian, Poisson equation, momentum, and many other mathematical functions.

An Hypothesis that Generates Forces

Pure mathematics is intrinsically decoupled from nature. To be useful, some rule, principle, law, or hypothesis is needed. That is what is done next. The generic field theory is coupled to nature with the *conservative field hypothesis*: *A force may be defined for every quantity that a field conserves.* This hypothesis is exactly opposite to current practice where conserved quantities are based upon forces and related symmetries.

All of the forces in Table 1 comply with the generic field theory components and the conservative field hypothesis. The field constant, column 3, is the quantity that a field conserves. Columns 3 to 7 are the components of the generic field theory derived above. The second row gives the mathematical formulas. Forces are named after the person who first experimentally measured the force, derived it, wrote about it, or is closely associated with a component. Interactions are named after the phenomena. The names of the forces and interactions may be interchanged.

Just a few comments will be made about the forces. The main purpose of the table is to show the broad application of the generic field theory. There should be sufficient examples in the table to indicate that the conservative field hypothesis works. The field constant is not always constant, but it is usually assumed to be.

The Galileo force conserves mass as well as the Newton force further down the list. It is suggested that this is the reason for Einstein's principle of equivalence. The Hooke force conserves the spring constant. The Huygen force conserves angular momentum. The Euler force conserves mass flux. The Gilbert force conserves magnetic charge and the Coulomb force conserves electric charge. The Fourier force conserves thermal diffusivity, and the Fick force conserves mass diffusivity.

Table 1. List of the force laws derived with the generic field theory and the use of the conservative field hypothesis: ***A force may be defined for every quantity that a field conserves.***

Force Law (1)	**Interaction (2)**	**Field Constant (3)**	**Scalar Potential (4)**	**Potential Energy (5)**	**Conservative Force (6)**	**Field Strength (7)**
Generic	Field	ρ	ϕ	$U = \rho\phi$	$\mathbf{F} = - \rho\nabla\phi$	$\mathbf{V} = - \nabla\phi$
Galileo	Inertial	m	- ar	- mar	$\mathbf{F_m} = m\mathbf{a}$	$\mathbf{a}$
Hooke	Spring	b	$r^2/2$	$b\, r^2/2$	$\mathbf{F_b} = - b\mathbf{r}$	$-\mathbf{r}$
Huygens	Centripetal	$m\omega r$	- log r	$- m\omega r \log r$	$\mathbf{F}_\omega = m(\omega r)^2/\mathbf{r}$	ω
Newton	Gravitational	m	- mG/r	$- m^2G/r$	$\mathbf{F_G} = m^2G/r^2$	$mG/\mathbf{r}^2$
Euler	Continuum	m/t	$- r^2/2t$	$- mv^2/2$	$\mathbf{F_v} = (m/t)\mathbf{v}$	$\mathbf{v}$
Gilbert	Electromagnetic	μ	$- \mu/r$	$- \mu^2/r$	$\mathbf{F}_\mu = \mu^2/\mathbf{r}^2$	$\mu/\mathbf{r}^2$
Coulomb	Electromagnetic	e	- e/r	$- e^2/r$	$\mathbf{F_e} = e^2/\mathbf{r}^2$	$e/\mathbf{r}^2$
Fourier	Thermal	kr^2	- T	$- kr^2T$	$\mathbf{F_k} = k\mathbf{r}^2\nabla T$	∇T
Fick	Mass Diffusion	D_ir^2	$- c_i$	$- D_ir^2c_i$	$\mathbf{F}_D = D_ir^2\nabla c_i$	∇c_i
Einstein	Strong	mc^2	- log r	$- mc^2 \log r$	$\mathbf{F_c} = mc^2/\mathbf{r}$	$1/\mathbf{r}$
Planck	Quantum	$h/2\pi$	- c/r	$- hc/2\pi r$	$\mathbf{F}_h = hc/2\pi\mathbf{r}^2$	$c/\mathbf{r}^2$

The components of most of the forces should be familiar even for the Einstein force that conserves mass-energy and the Planck force that conserves the quantum. However, it may come as a surprise that the well-known Einstein $E = mc^2$ and the Planck $E = h\omega/2\pi$ are actually components of forces.

Other forces may be derived with the generic field theory.

Redefinition of the Four Fundamental Forces

As mentioned before, the four fundamental forces are the gravitational, electromagnetic, weak, and strong forces. These four forces were defined from empirical observations. All of the phenomena of nature could be reduced to these four. What criteria, other than experimental observation, could be used to define fundamental forces from the list in Table 1? About the only rule that applies to Table 1 might be: *Fundamental forces are based upon fundamental constants*. This may be a circular argument that ultimately depends upon empirical practice, but it is adopted here. The redefinition of the four fundamental forces and the unification problem is expressed by the *Heaston Equations of Unification* in Figure 1.

Force	Equation	Interaction
Newton	$F_G = m^2G/r^2$	Gravitational
Coulomb	$F_e = e^2/4\pi\varepsilon_0 r^2$	Electromagnetic
Planck	$F_h = hc/2\pi r^2$	Quantum
Einstein	$F_c = mc^2/r$	Strong

Figure 1. Heaston Equations of Unification

The Heaston equations are similar to the Maxwell equations. Each force represents different phenomena. In addition, there are interactions between and among the different forces and ultimately an overall unification. The interactions of the four Heaston equations fulfill most of the goals of super unification without resorting to gauge theory, renormalization, or the insertion of arbitrary constants. This approach is much simpler.

A few comments about the individual forces will be given here. The Newton gravitational force and the Coulomb electromagnetic force are unchanged from standard practice. There is nothing new about these forces. On the other hand, the Planck force is a major surprise. It replaces the weak force in the standard model. It was not possible to identify any conserved quantity due exclusively to the weak force in order to derive a force law with the generic field theory. The Planck force, which may already have been observed in the Casimir effect, has a major theoretical significance. Moreover, the quantum is introduced through the Planck force. The Einstein force is a new force law that represents the strong force. As will be seen, the Einstein force appears to adequately match experimental observations at the low end and excellently fulfills theoretical expectations on the high end.

Design of the Universe

One diagram may be used to show the immense potential for interaction of the four Heaston equations. Figure 2 shows a plot of Log Force versus Log Distance for the four Heaston equations. The plot is not to scale, but it could be. It is given

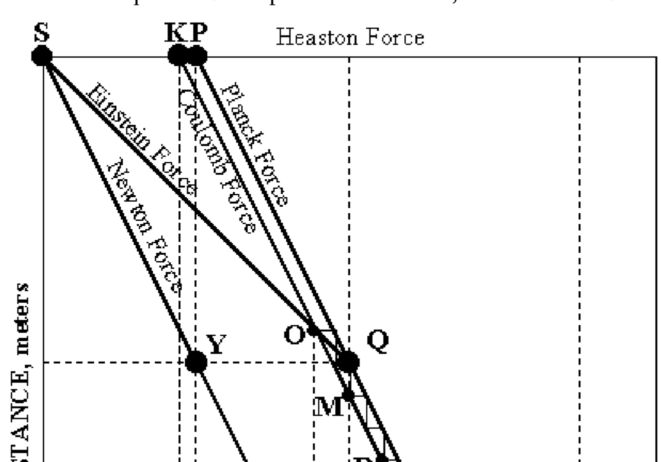

Figure 2. Design of the Universe based upon the Heaston Equations of Unification

the title of *Design of the Universe* because there are specific situations where the plot covers 10^{-50} meters to 10^{28} meters and 10^{-30} Newtons to 10^{44} Newtons. Most of the rest of this paper will be based upon various intersections and interactions of the four redefined fundamental forces. This paper contains information expanding on a three-part series published [2] with the title *Design of the Universe*.

The Newton, Coulomb, and Planck forces are all inverse square and, consequently, parallel to each other. Since the Einstein force is inverse linear, it cuts across the three inverse square forces. Major points of intersection are given letters associated with relevant individuals or phenomena. A brief explanation will be given of each of the points and regions on Figure 2. Emphasis will be placed on the most significant consequences. At least 150 functions of physics may be derived from the Heaston equations, 101 of which are derived on my web site: www.drheaston.com.

Compton Wavelength and the Strong Force. The key to the unification of the forces of nature is the Einstein force – a new force law for the strong force. This force intersects the Planck force at point Q, the Coulomb force at point O, and the Newton force at point S. Discussion of the interactions of the Heaston equations will start with the Einstein force.

Point Q is called the *Compton point* after Arthur Holly Compton (1892-1962). The letter Q was chosen because it was first called the *Quantum point* before an overall naming pattern was established. Point Q could also be called *the crossroads of physics* because it is a reference for so many phenomena. At point Q, the Einstein force is equal to the Planck force at the Compton wavelength, or *Compton length* for short. The experimental data [3] for the strong force also goes through point Q and tends to correspond best with the Einstein force. A derivative force that goes through point Q is the hypothetical Yukawa force, $F_Y = (mc^2)^2(2\pi/hc)$, which exhibits a pattern that is repeated in other forces. More will be said about this pattern and the Yukawa force later.

Classical Radius of the Electron. The Einstein force runs from slightly to the right of point Q upward to the left in Figure 2 to where it intersects the Coulomb force at point O, called the *Weyl point* after Hermann Weyl (1885-1955). The *Weyl length*, $r_O = e^2/4\pi\varepsilon_0 mc^2$, is the classical radius of the electron. The *Weyl force*, $F_O = (mc^2)^2(4\pi\varepsilon_0/e^2)$, has a pattern similar to the Yukawa force. Point O is used instead of zero, which was the way the classical radius was defined.

Gravitational Collapse to the Superforce. The Einstein force terminates at the Newton force at point S, the *Heaston point*, which was named after the author by a graduate student during a seminar at the University of Mississippi in 1977 [4]. The *Heaston length* is $r_S = mG/c^2$. This length is already known as a measure of relativistic behavior in astrophysics. The Heaston length is one-half the Schwartzschild limit that is supposed to be the horizon limit of black holes. Although the cause of this difference is unknown, the Heaston length is referred to as the gravitational collapse limit.

Another unexpected and unusual property is associated with point S. The *Heaston force* at point S exhibits the same form as the Yukawa and Weyl forces. All three are $(mc^2)^2$ times the inverse of mass and the constants of the forces intersected by the Einstein force. This means that the formula for the Heaston force is $F_S = (mc^2)^2(1/m^2G)$, which surprisingly reduces to $F_S = c^4/G = 1.21 \times 10^{44}$ N. This force has such a large magnitude that the "S" in point S stands for *super-force*. Point S moves right or left as a function of particle mass, but never upwards. As particle mass increases point S moves towards points K and P in Figure 2.

Planck Scale of the Big Bang. Point P, the *Planck point*, is the home of the Planck scale of big bang theory. The Planck point is named after Max Karl Ernst Ludwig Planck (1858-1947), who originally derived a characteristic length, time, and mass that were named after him. He did not use any particular theory to make these derivations, but used dimensional analysis. The Planck functions can be derived with the Heaston equations.

The Planck force is equal to the Heaston force at point P, which occurs at the *Planck length*. The *Planck time* is obtained by dividing the Planck length by the speed of light. The *Planck mass* occurs when point S moves to overlay point P and the Newton gravitational force is equal to the Einstein strong force is equal to the Planck quantum force is equal to the Heaston superforce, $F_G = F_c = F_h = F_S$, at the Planck length, time, and mass. Since the Planck mass is considered to be the largest possible particle mass, why should the Heaston force not be the strongest possible force in the universe – namely, the SUPERFORCE?

A number of dimensional constant functions may be derived at point P. These include the Planck length, time, frequency, mass, momentum, energy, temperature, density, acceleration, and flux. The Planck radiation flux, L_h, reduces to the interesting equation of $L_h = h\omega^2/2\pi$. These functions are not derived here because of space, but they may be easily derived starting with just the Heaston force, the Newton force, and the Planck force.

Termination of the Uncertainty Principle. Because of all the constant Planck functions, the uncertainty principle terminates at point P.

$$c^4/G \times (hG/2\pi c^3)^{1/2} \times (hG/2\pi c^5)^{1/2} = h/2\pi$$

$$(hc/2\pi G)^{1//2}c \times (hG/2\pi c^3)^{1/2} = h/2\pi$$

$$(hc/2\pi G)^{1//2}c^2 \times (hG/2\pi c^5)^{1/2} = h/2\pi$$

Note in the first equation that the Heaston force times the Planck length times the Planck time is exactly equal to the quantum. In the second equation, the Planck momentum times the Planck distance is equal to the quantum. Finally, the third equation shows that the Planck energy multiplied by the Planck time is also equal to the quantum. These functions are all constant and determinant at point P.

Point Solution to Einstein's Unified Field Theory. Point K, the *Coulomb point*, is a point solution to Einstein's unified field theory. The conditions at point K do not constitute a derivation of Einstein's unified field theory, but very likely a result that could have been the result of solving his theory; that is, the point where the gravitational and electromagnetic forces are equal. Einstein's goal was to unify the gravitational and the electromagnetic forces. His approach was to start with his field equation of general relativity and merge it with Maxwell's equations of electromagnetism such that either gravitation or electromagnetism would result from the unified field.

Three steps will be used to derive the conditions at point K using only functions that might have been known to Einstein. In the first step, The gravitational force can be set equal to the electromagnetic force at point K, but because both forces are inverse square, the result is the *Coulomb mass*, m_K, over all lengths. Scalar magnitudes will be used.

$$m^2G/r^2 = e^2/4\pi\varepsilon_0 r^2$$

$$m_K = (e^2/4\pi\varepsilon_0 G)^{1/2} = 1.86 \times 10^{-9} \text{ kg} = 1.05 \times 10^{18} \text{ GeV}.$$

The second step involves the need for an independent equation involving electric charge and mass. It was known in the 1920s that the Coulomb potential energy could be set equal to mc^2 from Einstein's special theory of relativity to derive a length called the classical radius [5], when the mass of the electron was used. Einstein may, or may not, have known this. If this equation is considered to be the mass-energy equivalence of electric charge, then different masses apply other than the mass of the electron. In this case a convergence distance, the *Coulomb length* r_K, is defined when m_K is inserted,

$$e^2/4\pi\varepsilon_0 r_K = m_K c^2$$

$$r_K = (e^2G/4\pi\varepsilon_0 c^4)^{1/2} = 1.38 \times 10^{-36} \text{ meters}.$$

Division of r_K by the speed of light yields a *Coulomb time*, t_K.

The third step is to insert m_K and r_K into the gravitational force and the electromagnetic force to yield the superforce:

$$m_K{}^2G/r_K{}^2 = e^2/4\pi\varepsilon_0 r_K{}^2 = c^4/G = 1.21 \times 10^{44} \text{ N}.$$

Thus, by working without knowledge of the superforce, it is possible to define the same conditions as at point K in Figure 2.

In summary, point K brings together the classical gravitational force, the electromagnetic force, and components of special relativity and general relativity – all of which were known to Einstein. Why did Einstein overlook this solution? The answer to this question is contained in Einstein's field equation of general relativity, which is expressed in one form in the following.

$$R_{\mu\nu} - (1/2)g_{\mu\nu}R + (1/2)g_{\mu\nu}\lambda = (8\pi G/c^4)T_{\mu\nu} = 8\pi T_{\mu\nu}/(1.21 \times 10^{44})$$

Einstein frequently said that the right-hand side of his equation was "ugly." So he made an assumption to use units where c = G = 1 in these units. The superforce became invisible. The magnitude was still present but its cause was hidden. Physicists are taught to make the same assumption that Einstein did [6]. The superforce has a hidden role in many different equations in physics [7, 8].

Point K exhibits many features similar to point P. Every characteristic dimension at point P has its counterpart at point K: Coulomb length, time, frequency, mass, momentum, energy, temperature, density, acceleration, and flux. A Coulomb scale at point K exists that corresponds to the Planck scale at point P. The corresponding Planck and Coulomb dimensions are all related by the square root of the fine structure constant. Since point K cannot move towards point P, and vice versa, it is suggested that the Planck mass is the origin of bosons and the Coulomb mass is the origin of fermions. The Coulomb energy is approximately 10^{18} GeV, which is somewhat higher than the convergence energy of 10^{16} GeV predicted by the standard model [9].

Nominal Strong Force. We move downward in Figure 2 to point Y, the *Yukawa point*. This point reveals a unique symmetry in the interactions of the Heaston equations. The Yukawa point occurs for the Newton gravitational force at the Planck length at all masses from the Planck mass downwards. The *Yukawa force* is the magnitude of the Newton force at the Planck length, which is the same as derived earlier, $F_Y = (mc^2)^2(2\pi/hc)$. For any given specific mass, the Yukawa force is equal to the force where the Einstein force is equal to the Planck force at point Q. The magnitude of the Yukawa force for the mass of a proton is exactly equal to the experimentally measured strong force at the Compton length of a proton. This result happens because points Y, S, P, and Q are the apexes of a parallelogram in Figure 2.

The Yukawa point is named after Hideki Yukawa (1907-1981) because the *Yukawa potential* can be derived at point Q from the Einstein force and the experimentally observed strong force. In other words, the Yukawa potential is the sum of two potentials. Assume that the binding force of quarks has a potential equal to "- ar," where "a" is a constant. As given in the earlier table, the scalar potential of the Einstein force, "- ln r," may be added to the above potential by the principle of superposition. After some mathematical manipulations, the result is the Yukawa potential. This interpretation makes the Yukawa potential more compatible with the quark structure of hadrons.

Physical Meaning of the Eddington Number. Point E at the middle of the bottom of Figure 2 is called the *Eddington point* after Arthur Stanley Eddington (1882-1944). The Newton gravitational force at the Compton length gives the *Eddington force*. The Heaston force divided by the Eddington force at point E is the theoretical basis of the *Eddington number*, $g_E = (hc/2\pi mc^2)^2$, which is equal to 10^{80} for an arbitrary mass. Since there happens to be about 10^{80} electrons and protons in the universe, Eddington tried to explain his number by what amounted to numerology. He lost some credibility in over emphasizing this number. But, the Eddington number is actually the relative strength of the strongest force to the weakest force. The Eddington number is ubiquitous. It may also be derived at least 25 different ways from the Heaston equations. For example, the square of the ratio of the Compton length divided by the Heaston length is the Eddington number, as well as the fourth power of the ratio of the Compton length divided by the Planck length.

Gravitational Coupling Constant. Up until the above discussion of the Eddington number, the emphasis was on properties at specific points. Now, the discussion concerns relational aspects of different points to each other. Figure 2 may be used to describe the relative magnitudes of various forces and various lengths. The relative strength of the Eddington force at point E to the Yukawa force at point Q is the *Newton number*, which is also known as the gravitational coupling constant, $g_G = 2\pi m^2G/hc = 5.88 \times 10^{-39}$ for the mass of the proton.

Electromagnetic Coupling Constant. Point M, which is the Coulomb force at the Compton length, is the Maxwell point. The Maxwell force divided by the Yukawa force is the Coulomb number, g_e, $= 2\pi e^2/4\pi\varepsilon_0 hc = \alpha = 1/137$, also known as the electromagnetic coupling constant and the fine structure constant.

Strong Force Coupling Constant. The coupling constants may be defined relative to the Yukawa force, Einstein force, or Planck force at point Q. Normal practice uses the Planck force, without knowing of its existence. Thus, the *Einstein number*, $g_c = 2\pi mcr/h$, otherwise known as the strong interaction coupling constant, may be calculated as the relative strength of the Einstein force to the Planck force. The Einstein number is greater than one to the right of point Q, equal to one at point Q, and less than one to the left of point Q. Measured values are slightly greater than one.

Minimum Bohr Orbit. Point B is called the *Bohr point* after Neils Bohr (1885-1962). *The Bohr length* at point O is also known as the minimum Bohr orbit of the electron.

The Planck and the Coulomb forces in Figure 2 are both inverse square and therefore parallel to each other. Beginning at point O, the classical radius, where the Einstein force is equal to the Coulomb force, a series of stairsteps can be drawn between the Planck and the Coulomb forces. Each stairstep is referred to as a Planck-Coulomb band. It has been known for a long time [10] without awareness of the Planck force, that the classical radius, Compton wavelength, and Bohr radius were related by the equation $r_n = r_O/\alpha^{n/2}$, where n = 0, 2, 4 for the lengths given. This equation applies to all of the stairsteps in Figure 2.

Prediction of Maximum Atomic Orbit. When n = 6 in the above stairstep equation, the result is the Rydberg length, r_R, named after Johannes Robert Rydberg (1854-1919) because $r_R = 1/4\pi R_\infty$. It is predicted that the Rydberg length should be the maximum atomic orbit because of the presence of the Rydberg number, R_∞, and the fact that the Weyl, Compton, and Bohr lengths are each separated by two Planck-Coulomb bands.

Explanation of the Casimir Effect. Another two stairsteps down at n = 8 in Figure 2 is point Z, the *Casimir point*, named after H. B. G. Casimir. When two neutral plates are placed about a micrometer from each other, an attractive force is observed that is called the Casimir effect. Experimental observations report [11] this force as a force per unit area, or pressure, $P = khc/2\pi d^4$, where k is some numerical value and d is the area of the test plates. Notice the similarity to the Planck force. It is suggested that what is being measured as the Casimir effect is really the Planck force. The Casimir length when the mass of an electron is used is $r_Z = 9.94 \times 10^{-7}$ m.

Theoretical Structure of the Electromagnetic Spectrum. The stairsteps observed above that defined points O, Q, M, B, R, and Z exhibit mostly geometrical characteristics. However, wave-particle duality is exhibited in that the stairsteps also correspond to wavelength dimensions. The same equation applies in wavelength form, where n = 0, 1, 2, 3,… for all values of n.

$$\lambda_n = \lambda_O/\alpha^{n/2}$$

This equation can be expanded as a function of fundamental constants and the mass of the electron.

$$\lambda_n = [(c^{n-4}/m_e^{2})(4\pi\varepsilon_0/e^2)^{n-2}(h/2\pi)^n]^{1/2}$$

The above equation defines a series of Planck-Coulomb bands that represent a theoretical structure of the observed electromagnetic spectrum. A pair of two Planck-Coulomb bands, or two stairsteps, spans a spectral band. Only ten steps of the electromagnetic spectrum are plotted in Figure 2. Twenty-five steps are required for the total observed spectrum.

Table 2. Theoretical Structure of the Electromagnetic Spectrum

n	Wavelength meters	Theoretical Spectral Band	Wavelength meters	n
0	2.82×10^{-15}	Hard Cosmic Rays	3.30×10^{-14}	1
1	3.30×10^{-14}	Soft Cosmic Rays	3.86×10^{-13}	2
2	3.86×10^{-13}	Hard Gamma Rays	4.52×10^{-12}	3
3	4.52×10^{-12}	Soft Gamma Rays	5.30×10^{-11}	4
4	5.30×10^{-11}	Hard X-rays	6.19×10^{-10}	5
5	6.19×10^{-10}	Soft X-rays	7.26×10^{-9}	6
6	7.26×10^{-9}	Vacuum Ultraviolet	8.49×10^{-8}	7
7	8.49×10^{-8}	Ultraviolet-Visible	9.95×10^{-7}	8
8	9.95×10^{-7}	Near Infrared	1.16×10^{-5}	9
9	1.16×10^{-5}	Far Infrared	1.36×10^{-4}	10
10	1.36×10^{-4}	Sub-Millimeter	1.60×10^{-3}	11
11	1.60×10^{-3}	Extremely High Frequency (EHF)	1.87×10^{-2}	12
12	1.87×10^{-2}	Super High Frequency (SHF)	2.20×10^{-1}	13
13	2.20×10^{-1}	Ultra High Frequency (UHF)	2.56×10^{0}	14
14	2.56×10^{0}	Very High Frequency (VHF)	3.00×10^{1}	15
15	3.00×10^{1}	High Frequency (HF)	3.51×10^{2}	16
16	3.51×10^{2}	Medium Frequency (MF)	4.11×10^{3}	17
17	4.11×10^{3}	Low Frequency (LF)	4.81×10^{4}	18
18	4.81×10^{4}	Very Low Frequency (VLF)	5.63×10^{5}	19
19	5.63×10^{5}	Extremely Low Frequency (ELF)	6.59×10^{6}	20
20	6.59×10^{6}	Extremely Low Frequency (ELF)	7.71×10^{7}	21
21	7.71×10^{7}	ELF – Micropulsation A @ n = 21	9.09×10^{8}	22
22	9.09×10^{8}	Ultra Low Frequency (ULF) Micropulsation B @ n = 22	1.06×10^{10}	23
23	1.06×10^{10}	Micropulsation C @ n = 23	1.24×10^{11}	24
24	1.24×10^{11}	Micropulsation D @ n =24	1.45×10^{12}	25
25	1.45×10^{12}	Prediction of E @ n = 25, F @ n = 26	1.70×10^{13}	26

Table 2 indicates the predicted spectral bandwidths for the known electromagnetic spectrum. The electromagnetic spectrum is supposedly continuous but different wavelengths are associated with different phenomena. There are different interactions with materials and the atmosphere. Enough distinctions exist for different spectral bands to have there own names. It should not be surprising that there might be an overall theoretical structure to the electromagnetic spectrum.

The following comments apply to Table 2. All wavelengths are theoretical. Since the Planck-Coulomb bands seem to come in pairs, pairing is indicated by indenting. There is not a good match from about n = 0 to n = 4 for cosmic rays and gamma rays. From n = 4 to about n = 12, there is good match for X-rays, ultraviolet, infrared, and millimeter waves. The standard Radio Spectrum begins at about n = 11. Since the radio spectrum is arbitrarily defined in decades (10), and the theory is a function of the square root of the fine structure constant (11.7), skewing of theory versus observation takes place until the Extremely Low Frequency (ELF) band comes back on track at n = 20. Each of the very long wave micropulsation bands seem to fall on a specific node. Consequently, micropulsation bands are predicted at n = 25 and n = 26.

The literature is not consistent on specifying spectral bands. Some judgment is needed on matching spectral bands to theory. Once that is done, the match between theory and observations is excellent overall. The Planck-Coulomb bands offer a way to reach worldwide consistency for specifying spectral bands.

Dirac's Large Number Hypothesis. Paul Adrien Maurice Dirac (1902-1984) made the observation in 1938 that many of the fundamental quantities in physics used in cosmology had similar numerical magnitudes [12]. Dirac essentially introduced the concept of what may be called cosmic numbers. Cosmic numbers are large and small numbers that occur frequently in descriptions of the universe. In my opinion there are two classes of cosmic numbers, which in turn have two sub-classes. There may be other numbers in addition to those listed.

Dimensionless Numbers

- Relational constants – pi, fine structure constant.
- Mass-dependent relational constants – Eddington number, gravitational coupling constant, classical radius, Bohr radius, Rydberg constant

Dimensional Numbers

- Fundamental constants – speed of light, gravitational constant, Planck constant, and electric charge.
- Derivative constants – Planck length, time, frequency, mass, momentum, energy, temperature, density, acceleration, and flux; and Coulomb length, time, frequency, mass, momentum, energy, temperature, density, acceleration, and flux.

Dirac was essentially talking about dimensionless mass-dependent relational numbers. He observed that different combinations of large and small numbers seemed to be equal in magnitude. He also wondered whether a particular combination might define the age or size of the universe. In my opinion, his choice of numbers made use of a hypothetical Dirac length, noted as point D in Figure 2. If this Dirac length is divided by the Bohr length and set equal to the Compton length divided by the Heaston length, the hypothetical Dirac length may be derived. This result comes close to what Dirac used. He dropped out a proportionality factor that is included in my result. Solving for the Dirac length gives a function that is inversely proportional to mass. The mass of hydrogen gives a result that falls short of the size or age of the universe.

On the other hand, if the ratio of lengths is slipped to the right to a hypothetical Hubble length at point H, a better result is achieved. The Hubble length divided by the Rydberg length is now set equal to the Compton length divided by the Heaston length. The Hubble length for a relative abundance of species of 1.4 gives 10^{28} meters and 1.7 gives 10^{26} meters for the size of the universe. These dimensions correspond to an age of the universe of 20 billion and 15 billion years, respectively.

My rationale for these calculations is as follows. It is as if the rectangle with opposite corners at point S and point E is shifted so that the Heaston length is on the Bohr length for Dirac and on the Rydberg length for Hubble. It may be supposed that the minimum orbit Bohr length is red-shifted all the way to the maximum atomic orbit Rydberg length. This supposition needs to be further examined. Nevertheless, the appropriate answer seems to result.

The Asymptotic Box. The Design of the Universe symbolized by Figure 2 presents a philosophic dilemma. *It appears that we live in an asymptotic box.* An asymptote is a mathematical line that may be approached but not reached whether coming from either side. Six different asymptotes are summarized in Table 2. The first four are relevant to Figure 2.

Side 1, the right side of the box in Figure 2, is the speed of light, the assumed limit of the expansion of the universe. Einstein's special theory of relativity and Maxwell's equations of electromagnetism apply. Matter cannot reach the speed of light. On the other side of this asymptote are mathematically derived particles called tachyons that cannot go slower than the speed of light. There is "warp speed" from *Star Trek* movies. There are also bubbles and multi-universes.

Side 2, the bottom of the box in Figure 2, is the asymptote of absolute zero. The second law of thermodynamics and entropy apply. Thermal death waits on the other side.

Side 3, the left side of the box in Figure 2, is gravitational collapse. The Heaston length applies. On the outside are black holes and worm holes. Hawking

Table 2. The asymptotic box of the physical world.

INSIDE THE BOX	OUTSIDE THE BOX
Side 1: Matter cannot exceed the speed of light.	Side 1: Tachyons, "warp speed", and multi-universes are on the outside.
Side 2: The bottom of the box is absolute zero.	Side 2: Thermal death awaits beyond absolute zero.
Side 3: There is a gravitational collapse limit for matter.	Side 3: Black holes and worm holes begin at the collapse horizon.
Side 4: The largest possible force is the finite superforce.	Side 4: Singularities, inflation theory, and string theory are outside.
Side 5: The front of the box is creation, birth, beginning of time.	Side 4: Preternal existence is somewhere beyond.
Side 6: The back of the box is death, end of life, end of time.	Side 5: Eternal life stretches into eternity.
• The laws of physics apply inside the box.	• The laws of physics fail outside the box.
• The natural world exists inside	• The supernatural is dominant outside

the box.	the box.
• Anthropic principles apply inside the box.	• No limits exist for anything outside of the box.

has predicted that black holes might obey the uncertainty principle and evaporate energy. But, if the uncertainty principle becomes determinant at the Heaston force, this asymptote cannot be crossed.

Side 3, the top of the asymptotic box in Figure 2, is the superforce. The Heaston equations and Einstein's general theory of relativity apply. On the other side are singularities, inflation theory, and string theory. Inflation theory defines two stages, one starts from a singularity and goes to the Planck scale and the other from the Planck scale. String theory seems to apply at the Planck scale only. String theory began with the Kaluza-Klein five-dimensional variation of Einstein's general relativity and grew to other dimensions. It is suggested that the Heaston force is an asymptote buried in both inflation and string theories.

Sides 5 and 6, the front and the back of the asymptotic box are not shown in Figure 2. These sides have as their asymptotes creation and death, respectively. Reality testifies to these asymptotes. Philosophy and religion define the outside.

The laws of physics apply to the natural world within the asymptotic box. The laws of physics fail in the supernatural world outside the box. Perhaps, God has put us in the box where we belong. As it says in Hebrews 11:3 of the Bible, "By faith, we understand that the Universe was formed at God's command, so that what is seen was not made out of what was visible." It is quite possible that the asymptotic box is also an anthropic box.

Conclusions and Recommendations

The concept of force is defined in a new way so that force laws only are used. New force laws are derived that lead to a specific superforce. It appears that a point solution has been found for Einstein's unified field theory. The Eddington number, the coupling constants, and various cosmic numbers are all derived from relative forces, or characteristic distances, or sometimes from both. The continuous electromagnetic spectrum also has a discrete structure that corresponds to spectral bands. A maximum atomic orbit is predicted. A force law is derived that is similar to the measured Casimir effect. The Dirac large number hypothesis is explained and related to the Hubble constant. Finally, it is suggested that the observable world is bounded in an asymptotic box that may explain shortfalls in inflation and string theories. Many of the goals of unification are achieved. Gravity is included.

Several recommendations for further theoretical and experimental work follow from what has been presented.

- Expand the applications of the generic field theory to define other mathematical relationships.
- Derive other forces using the generic field theory and the conservative field hypothesis.
- Define the Fermi weak force using components of the generic field theory or interactions of the Heaston equations.

- Examine the strong force experimentally to verify the Einstein force.
- Check to see if electrons, or other fermions, react to the Einstein force.
- Determine if the Planck force truly represents the Casimir effect..
- Investigate the role of the Heaston force in solutions of the Einstein field equation of general relativity, inflation theory, and string theory.
- Explain the difference between the Heaston length and the Schwartzschild limit.
- Explore the possibility that the Rydberg length is the maximum atomic orbit.
- Structure the electromagnetic spectrum to comply with the proposed Planck-Coulomb bands.
- Extend the Planck-Coulomb bands to see if there is any pattern to the particle energy levels.
- Make observations of micropulsations at n = 25 and n = 26.
- Consider the implications of the observation that we live in an asymptotic box.

As the reader looks over this paper, he or she will see many familiar relationships of physics plus a few new ones. Each of the relationships is a piece of the puzzle that is the design of the universe. The universe appears indeed to be a beautiful, complex, coherent, and interdependent network of relationships from gravitational collapse to the edge of space. It is almost possible to conclude that the redefinition of the unification problem offers a hint of someday finding a theory of everything , or -- this may be as good as it gets.

REFERENCES

1. R. J. Heaston. “A New Look at the Concept of Force,” Speculations in Science and Technology, 6(5), 485-497, 1983.
2. R. J. Heaston. “Design of the Universe,” Galilean Electrodynamics, Three-part paper. “Part I – Redefinition of the Unification Problem, 9(4), 75-79, July/August 1998. “Part II – Consequences of Redefining the Fundamental Forces,” 10(2), 27-30, March/April 1999. “Part III – An Independent Pattern,” 23-28 March/April 2000.
3. E. D. Bloom, G. J. Freeman. “Quarkonium,” Scientific American, 246,42, May 1982.
4. R. J. Heaston. “The Evolution of the Concept of Force,” Seminar presented at the University of Mississippi, December 8, 1977.
5. H. Weyl. Space – Time – Matter, New York: Dover Publications, 260-261, 1922.
6. C. W. Misner, K. S. Thorne, J. A. Wheeler. Gravitation, San Francisco: W. H. Freeman & Co., 1973.
7. R. J. Heaston. “Identification of a Superforce in the Einstein Field Equations,” Journal of the Washington Academy of Sciences, 80(1), 25-36, March 1990.
8. R. J. Heaston. “Einstein’s Great Oversight,” Galilean Electrodynamics, 2(2), 23, March/April 1991.
9. S. Weinberg. “A Unified Physics by 2050?” Scientific American, 68-75, December 1999.
10. D. H. Menzel, Editor. Fundamental Formulas of Physics, Vol. 1, New York: Dover Publications, Inc., 149-150, 1960.
11. S. K. Lamoreaux. “Demonstration of the Casimir Force in the 0.6 to 6 μm Range,” Physical Review Letters, 78(1), 5-8, January 6, 1997.

12. M. Berry. Principles of Cosmology and Gravitation, Cambridge: Cambridge University Press, 136-139, 1976.